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L4: Entry 5 of 12 File: USPT Mar 16, 1999

US-PAT-NO: 5882034
DOCUMENT-IDENTIFIER: US 5882034 A

TITLE: Automobile airbag system

DATE-ISSUED: March 16, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
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US-CL-CURRENT: 280/735

CLAIMS:

We claim:
1. An automobile airbag system comprising:
a control module; and
at least one remote module responsive to said control module, said at least one remote module including a capacitor for providing energy to ignite a pyrotechnic material and further including an integrated circuit coupled to said capacitor and coupled for receiving a control signal from said control module;
wherein the integrated circuit comprises:
an address control logic circuit coupled to an input of said integrated circuit; and
a firing delay circuit having an input coupled to an output of the address control logic circuit.
2. The automobile airbag system as recited in claim 1 further including a squib responsive to said at least one remote module, said squib being coupled to said pyrotechnic material.
3. The automobile airbag system as recited in claim 2 wherein said squib is formed from polysilicon.
4. The automobile airbag system as recited in claim 3 wherein said squib has a resistance greater than two ohms.
5. The automobile airbag system as recited in claim 2 further including:
an airbag; and
an airbag inflator assembly coupled to said airbag, said airbag inflator assembly including said pyrotechnic material and said squib.
6. The automobile airbag system as recited in claim 5 wherein wiring between said at least one remote module and said squib is less than or equal 3.0 centimeters to minimize electromagnetic radiation pick up.
7. The automobile airbag system as recited in claim 6 wherein said capacitor is selected from capacitor types comprising aluminum solid capacitors with organic semiconductive electrolyte, specialty polymer capacitors with solid electrolyte, tantalum capacitors, and aluminum electrolytic capacitors.
8. The automobile airbag system as recited in claim 7 wherein said integrated circuit further comprises a first terminal coupled to said capacitor, a first output coupled to a first terminal of said squib and a second output coupled to a second terminal of said squib.
9. The automobile airbag system as recited in claim 8 wherein said integrated circuit further comprises:
a first transistor having a first electrode coupled to said capacitor, a control electrode responsive to said address control logic circuit, and a second electrode coupled to said first output of said integrated circuit; and

a second transistor having a first electrode coupled to said second terminal of said squib, a control electrode responsive to said address control logic circuit, and a second electrode coupled to a power supply terminal wherein said first and second transistors form a conductive path when enabled for providing current from said capacitor through said squib for igniting said pyrotechnic material.

10. The automobile airbag system as recited in claim 9 wherein said firing delay circuit includes:

a clock circuit;

a firing duration circuit responsive to said clock circuit;

a firing delay register responsive to said address control logic circuit for delaying an enable signal during an airbag deployment sequence;

a firing circuit responsive to said firing duration circuit for enabling said first and second transistors; and

wherein said integrated circuit further includes:

a disarming circuit responsive to said firing duration circuit for discharging said capacitor.

11. The automobile airbag system as recited in claim 10 wherein said integrated circuit further includes:

a charge pump circuit responsive to said firing circuit for enabling said first transistor; and

a voltage regulator coupled to said first terminal of said integrated circuit for providing a reference voltage to power said address control logic circuit, said clock circuit, said firing duration circuit, said firing delay register, and said firing circuit.

12. The automobile airbag system as recited in claim 11 wherein said capacitor and said integrated circuit are placed in a plug assembly that couples to said squib.

13. A method for reducing current applied to a squib for igniting pyrotechnic material to inflate an airbag, the method comprising locating a capacitor and integrated circuit respectively for providing power and forming a conductive path through the squib within an airbag assembly to minimize electromagnetic pickup.

14. An automobile airbag system comprising:

a control module;

a plurality of airbag assemblies wherein each airbag assembly comprises:

a plug assembly remote module responsive to said control module, said remote module including a capacitor for providing power;

an airbag inflator assembly including a squib responsive to said remote module for igniting pyrotechnic material, said squib being powered by said capacitor; and

an airbag for receiving gases released by said airbag inflator assembly.

15. The automobile airbag system as recited in claim 14 wherein each airbag assembly further includes an integrated circuit in said remote module, said integrated circuit being responsive to said control module for forming a conductive path from said capacitor through said squib to ground.

16. The automobile airbag system as recited in claim 15 wherein said integrated circuit comprises:

an address control logic circuit responsive to said control module;

a first transistor responsive to said address control logic circuit; and

a second transistor responsive to said address control logic circuit wherein said first transistor couples said squib to said capacitor and said second transistor couples said squib to ground.

17. The automobile airbag system as recited in claim 16 wherein said integrated circuit further includes a delay circuit responsive to said address control logic circuit for delaying enablement of said first and second transistors of said remote module.

18. The automobile airbag system as recited in claim 17 wherein each plug assembly remote module couples to a corresponding squib.

19. The automobile airbag system as recited in claim 18 wherein wiring between said integrated circuit of each remote module and said corresponding squib is less than 3.0 centimeters in length.

20. The automobile airbag system as recited in claim 19 wherein said squib has a resistance greater than two ohms.

21. An integrated circuit comprising:

an address control logic circuit coupled to an input of the integrated circuit;

a first transistor responsive to said address control logic circuit; and

a second transistor responsive to said address control logic circuit, wherein said first transistor is coupled to a first terminal and a first output of said integrated circuit and said second transistor is coupled to a second terminal and a second output of said integrated circuit.

22. The integrated circuit of claim 21 further comprising a delay circuit responsive to said address control logic circuit for delaying enablement of said

first and second transistors.
23. The integrated circuit of claim 22, wherein the delay circuit comprises:
a clock circuit;
a firing duration circuit responsive to said clock circuit;
a firing delay register responsive to said address control logic circuit for delaying an enable signal; and
a firing circuit responsive to said firing duration circuit for enabling said first and second transistors.
24. The integrated circuit of claim 23, further comprising a disarming circuit responsive to said firing duration circuit.
25. The integrated circuit of claim 24 further comprising:
a charge pump circuit responsive to said firing circuit for enabling said first transistor; and
a voltage regulator coupled to said first terminal of said integrated circuit for providing a reference voltage to power said address control logic circuit, said clock circuit, said firing duration circuit, said firing delay register, and said firing circuit.

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L4: Entry 2 of 12 File: USPT Sep 28, 1999

US-PAT-NO: 5957490
DOCUMENT-IDENTIFIER: US 5957490 A

TITLE: Arrangement for protection of a vehicle occupant

DATE-ISSUED: September 28, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Sinnhuber; Ruprecht	Gifhorn	N/A	N/A	DEX

US-CL-CURRENT: 280/735; 280/736, 280/743.2

CLAIMS:

I claim:
1. A passenger protection arrangement for a vehicle comprising:
at least one air bag;
an inflation device for filling the air bag;
control means for controlling the operation of the inflation device so as to control a filling characteristic of the air bag; and
sensor means including a bag expansion detector for detecting the expansion behavior of a specified section of the air bag and supplying a corresponding signal to the control means to control the filling characteristic of the air bag.
2. A passenger protection arrangement according to claim 1 wherein the bag expansion detector comprises:
a tension member connected with the specified section; and
at least one transducer coupled to the tension member and responsive thereto to supply a signal to the control means.
3. A passenger protection arrangement according to claim 2 wherein the transducer is a tachometer.
4. A passenger protection arrangement according to claim 2 wherein:
the tension member includes magnetically active metal particles; and
the transducer is arranged to detect magnetic asymmetries generated by motion of the metal particles during inflation of the air bag.
5. A passenger protection arrangement according to claim 2 wherein:
the tension member includes a stripe pattern; and
the transducer comprises an optical sensor responsive to motion of the stripe pattern during inflation of the air bag for detection of expansion behavior.
6. A passenger protection arrangement according to claim 1 wherein the sensor means comprises:
at least one pressure sensitive layer film fastened to the specified section of the air bag; and
a signal-transmitting line for transmitting signals from the pressure sensitive layer to the control unit.
7. A passenger protection arrangement according to claim 1 wherein the sensor means comprises:
at least one piezo element fastened to the specified section of the air bag; and
signal-transmitting means for transmitting signals from the at least one piezo element to the control unit.
8. A passenger protection arrangement according to claim 1 wherein the control unit includes storage means for storing in at least one characteristics field at least one reference characteristic defining air bag expansion behavior with time when the expansion is unimpeded by an obstacle, and means for comparing signals generated by the sensor means after activation of the inflation device with the at least one reference characteristic and generating a control signal for influencing

operation of the inflation device upon occurrence of a specified difference between the signals and the reference characteristic.
9. A passenger protection arrangement according to claim 1 wherein the inflation device comprises a gas generator having a mass flow which is variably adjustable and wherein the mass flow of the gas generator is controlled by the control means in response to signals from the sensor means.
10. A passenger protection arrangement according to claim 9 wherein the inflation device includes a valve structure by which the mass flow of gas produced by the gas generator after initial filling of the air bag is at least partially directable outside the air bag in response to a signal from the control means based on a signal produced by the sensor means.
11. A passenger protection arrangement according to claim 1 wherein the location of the specified section of the air bag is chosen with reference to the operation of the inflation device so that, upon filing of the air bag, the specified section is the first section to be impacted by the mass flow of gas.
12. A passenger protection arrangement according to claim 1 wherein the air bag is folded around the inflation device and the air bag and the inflation device form an air bag module.
13. A passenger protection arrangement according to claim 2 wherein the transducer is fastened to a housing for the inflation device.
14. A passenger protection arrangement according to claim 1 wherein the vehicle includes a dashboard and a floor space beneath the dashboard and wherein the air bag is located in a region of the floor space which is below the dashboard and is set back behind the face of the dashboard.
15. A passenger protection arrangement according to claim 14 wherein the dashboard has surface sections facing the floor space which form a firing channel for the air bag.
16. A passenger protection arrangement according to claim 14 wherein the air bag is positioned below the dashboard without any airbag cover.
17. A passenger protection arrangement according to claim 15 wherein the shape of the firing channel is selected so that an air bag mounted in the dashboard is not apparent to a passenger properly accommodated on an adjacent vehicle seat.
18. A passenger protection arrangement according to claim 1 wherein the sensor means comprises:
at least one extendable member which is fastened at a first end to the specified section of the air bag and at a second end at least indirectly to a fixed structure part and which is capable of being extended from a normal rest condition by inflation of the air bag;
at least one tearing element which is fastened at a first end to the extendable member in the region of the specified section of the airbag and at a second end at least indirectly to the fixed structural part, and which is capable of being separated from one of the extrudable member and the fixed structural part to generate a sensor signal.
19. A passenger protection arrangement according to claim 18 wherein the extendable member is a strap folded together in loops and the at least one tearing element includes a plurality of straplike tearing elements fastened to corresponding portions of the extendable member, the corresponding portions being distributed along the length of the extendable member according to a predetermined arrangement.
20. A passenger protection arrangement according to claim 18 including an electric signal line which is actuatable to supply a sensing signal by the separation of the at least one tearing element from the fixed structural part.
21. A passenger protection arrangement according to claim 18 wherein the fixed structural part comprises a plug base in which a plug held at the second end of the tearing element is capable of being secured; and
the plug is releasable from the plug base by the action of the inflation device to generate a sensor signal.
22. A passenger protection arrangement according to claim 18 wherein the control means include storage means for storing a characteristics field having at least one specified time interval between the time of release of the inflation device and the time of generation of a sensor signal resulting from separation from the fixed structural part or from the extendable member, and wherein the control unit generates a control signal to vary the filling characteristic of the air bag when the sensor signal is not detected within the specified time interval after release of the inflation device.
23. A passenger protection arrangement according to claim 1 wherein the sensor means comprises:
at least on infrared emitter capable of being turned on by the control means;
at least one reflecting region on the specified portion of the air bag to reflect

infrared light; and
at least one infrared receiver, connected to the control means for detecting infrared radiation received from the reflecting medium.
24. A passenger protection arrangement according to claim 23 wherein the reflecting region has a reflective coating on the air bag surface.
25. A passenger protection arrangement according to claim 23 wherein the air bag is made of an infrared light-reflecting fabric.
26. A passenger protection arrangement according to claim 23 wherein the infrared emitter and the infrared receiver are combined into a structural unit.
27. A passenger protection arrangement according to claim 26 wherein the structural unit is fastened to a housing for the inflation device.

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L4: Entry 1 of 12 File: USPT Nov 16, 1999

US-PAT-NO: 5984350
DOCUMENT-IDENTIFIER: US 5984350 A

TITLE: Vehicle safety system

DATE-ISSUED: November 16, 1999

INVENTOR-INFORMATION:

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US-CL-CURRENT: 280/735; 280/733

CLAIMS:

We claim:
1. A restraint system for protecting vehicle passengers during a crash event comprising:
(a) a vehicle seat including a substructure frame attached to the vehicle;
(b) a safety belt having a first non-extensible part and a second extensible part, wherein one end of each belt part is attached to the vehicle seat sub-structure for extension from the points of attachment to the substructure frame across a passenger's lap;
(c) fastening structures on ends of the belt parts non-attached to the substructure for uniting the parts over the passenger's lap;
(d) an inflatable member mounted on the non-extensible part of the belt on that side facing away from the passenger's lap;
(e) belt position orienting means operatively associated with the non-extensible belt part for maintaining the inflatable member mounted thereon facing away from the passenger's lap;
(f) a restraint system battery power supply which is independent of any other vehicle power source;
(g) an electrical switching combination contained in the belt part fastening structures that permit activation of the inflatable member only when the inflatable member is positioned facing away from the passenger's lap;
(h) a source of inflating gas operably joined to the inflatable member;
(i) a crash event sensor, and
(j) system electronics mounted on the seat substructure frame for electrically interconnecting the crash event sensor, the source of inflating gas, the battery power supply and the electrical switching combination.
2. A vehicle restraint system for protecting vehicle passengers during a crash event comprising:
(a) a vehicle seat including a substructure frame attached to the vehicle;
(b) a safety belt having a first non-extensible and a second extensible part, each attached at one end to the vehicle seat substructure frame and across a passenger's lap;
(c) fastening structures on ends of the belt parts non-attached to the substructure for uniting the parts about the passenger's lap;
(d) an electrical switching combination contained in the belt part fastening

structures;
(e) an inflatable member attached to the belt;
(f) a source of inflating gas operably joined to the inflatable member;
(g) a restraint system battery power supply which is independent of any other vehicle power source;
(h) a crash event sensor;
(i) system electronics electrically interconnecting the crash event sensor, the source of inflating gas and the battery power supply and regulating the supply of power from the battery to the event sensor to discrete pulses of preselected duration.
3. A vehicle restraint system as defined in claim 1 or 2 wherein the system electronics, is contained within a radiant energy shielding housing supported by the vehicle seat frame.
4. A vehicle restraint system as defined in claim 1 wherein the system electronics includes switching means connected between the system battery power supply and the source of inflating gas for rendering the system electronics operable when it is mounted on the substructure frame.
5. A vehicle restraint system as defined in claim 4 wherein a switching means operator separate from the switching means is supported by the seat frame in position for activating the system electronics when the electronics are mounted on the seat frame.
6. A vehicle restraint system as defined in claim 1 wherein the electrical switching combination in the belt fastening structures comprises at least one reed switch mounted on one belt part and a reed switch operator mounted on the other belt part.
7. A vehicle restraint system as defined in claim 6 wherein the restraint system includes an extra belt part for disabling connected between the reed switch and the reed switch operator attached to the extensible and non-extensible belt parts, the system electronics.
8. A vehicle restraint system as defined in claim 6 wherein the reed switch operator is a magnet.
9. A vehicle restraint system as defined in claim 6 wherein: the fastening structures include a coupling tang and a buckle and the reed switch is mounted on the coupling tang secured to the end of the first belt part and the reed switch operator is carried in the buckle secured to the end of the second belt part.
10. A vehicle restraint system as defined in claim 6 wherein at least two reed switches are mounted on the one belt part.
11. A vehicle restraint system as defined in claim 1 wherein the source of inflating gas and the system electronics include structure for enabling introduction of gas into the inflatable member at predetermined controlled rates.
12. A vehicle restraint system as defined in claim 1 wherein the restrained system battery power supply comprises at least two individual batteries connected for providing the system electronics with at least two levels of voltage.
13. A system as defined in claim 12 in which the batteries are connected in series.
14. A vehicle restraint system as defined in claim 1 wherein multiple sources of inflating gas are provided and the system electronics includes a firing program for effecting release of gas into the inflatable member in a preselected manner.
15. A vehicle restraint system as defined in claim 1 wherein the belt position orienting means comprises a torsion resisting element which is attached to the non-extensible belt part carrying the inflatable member.
16. A vehicle restraint system as defined in claim 15 wherein the belt position orienting means is a gas supply tube shaped for maintaining the belt part in position with the inflatable member facing away from the user's lap.
17. A vehicle restraint system as defined in claim 15 wherein the torsion resisting element is a substantially flat strap.
18. A vehicle restraint system as defined in claim 1 wherein the fastening structures on the ends of the belt parts non-attached to the substructure include physical means permitting connection therebetween only when the inflatable member is facing away from the passenger's lap.
19. A vehicle restraint system as defined in claim 18 wherein the physical means comprises an extension on one fastening structure for reception into a position orienting opening on the other fastening structure.
20. A vehicle restraint system as defined in claim 1 wherein belt position orienting means comprise the electrical switch combination contained in the belt part fastening structures.
21. A vehicle restraint system as defined in claim 1 wherein the crash event sensor is an accelerometer for generating a crash event output signal proportional to the rate of change in vehicle speed.

22. A vehicle restraint system as defined in claim 21 wherein the accelerometer incorporates a Hall effect device.
23. A vehicle restraint system as defined in claim 21 in which the accelerometer produces a signal only in response to changes in speed occurring along a single axis substantially parallel to the path of travel of the vehicle.
24. A vehicle restraint system as defined in claim 21 in which at least two accelerometers are used for producing the crash event output signal.
25. A vehicle restraint system as defined in claim 1 in which the system electronics include a gas firing circuit and a separate system control circuit.
26. A vehicle restraint system as defined in claim 25 in which the gas firing circuit and the system control circuit operate at different voltages received from the battery power supply.
27. A vehicle restraint system as defined in claim 2 wherein the system electronics includes a microprocessor that is programmed to poll the crash event sensor, recognize a crash event and initiate deployment of the inflatable member.
28. A vehicle restraint system as defined in claim 2 in which the system electronics include a gas firing circuit and a separate system control circuit.
29. An apparatus for controlling the operation of passive vehicle passenger restraint systems utilizing an inflatable cushion and a source of inflating gas, the apparatus comprising:
(a) a sensor responsible for transmission of a signal output reflecting the occurrence of a crash event;
(b) a restraint system battery power supply which is independent of any other vehicle power source;
(c) system electronics electrically interconnecting the crash event sensor and the battery power supply, which system electronics includes logic means programmed for regulating the supply of power from battery to the event sensor to discrete pulses of preselected duration; and
(d) a housing enclosing at least the sensor, battery power supply and system electronics for shielding out radiant energy.
30. An apparatus as define in claim 29 wherein the system electronics includes a microprocessor and an oscillator circuit connected for providing a timed energizing pulse to the sensor.
31. An apparatus as defined in claim 30 wherein a source of inflating gas is located within the radiant energy shielding housing.
32. An apparatus as define in claim 29 wherein switching means is operably connected between the system battery power supply and the source of inflating gas, for rendering the gas source inoperative when desired.
33. A vehicle safety restraint system for passenger protection during a vehicle crash event comprising: (a) an inflatable body restraint member extendable across a user's body (b) a source of inflating gas operatively connected to the body restraint member; (c) a crash event sensor to initiate inflation of the body restraint member; (d) a restraint system battery power supply which is independent of any other vehicle power source; and (e) power supply control elements operably connected between the battery power supply and the event sensor, whereby power is pulsed from the battery power supply to the event sensor to sample the condition thereof at preselected discrete intervals.
34. A restraint system as defined in claim 33 wherein a safety switch is electrically connected to the battery power supply for selectively controlling its connection to the remainder of the power supply control elements.
35. A restraint system as defined in claim 33 or claim 34 wherein the power supply control elements for pulsing power to the sensing means comprise a microprocessor.

36. A restraint system as defined in claim 33 wherein the event sensor comprises a Hall effect device.
37. A restraint system as defined in claim 33 wherein the inflatable body restraint member comprises: a first, non-extensible belt part having an inflatable bag mounted thereon for expansion in the direction away from a user's body.
38. A restraint system as defined in claim 37 wherein the first belt part includes a belt position orienting element for orienting a preselected side of the first belt away from the user's body.
39. A restraint system as defined in claim 38 wherein the first belt part position orienting element comprises a torsion resisting element that maintains an initial, preferred first belt part orientation.
40. A restraint system as defined in claim 39 wherein the torsion resisting element extends substantially the entire length of the first belt part.
41. A restraint system as defined in claim 37 wherein the first belt part has two ends, one end being attached to selected substructure and the second end having a tang for connecting to a buckle, whereby the first belt part is secured at both

ends over the lap of the user's body.
42. A restraining system as provided in claim 41 comprising a second belt part having two ends, one end being attached to selected substructure, and a buckle attached to the second belt part for releasable engagement with the first belt part tang, the second belt part being adjustable in length.
43. A restraint system as defined in claim 42 which includes an electrical switching combination in the tang and buckle which activates the safety restraint system when the tang and buckle are mutually engaged with the inflatable bag away from the user's body.
44. A restraint system as defined in claim 43 wherein the electrical switching combination comprises a reed switch and a magnet.
45. A restraint system as defined in claim 44 wherein the reed switch is mounted on the tang and the magnet is mounted on the buckle.
46. In a vehicle safety restraint system having an inflatable member attached to a safety belt, a source of gas, a crash event sensor and a source of battery power that is independent of any other vehicle power source, the combination comprising: electronic control means operably connecting the battery power source to the crash event sensor for regulating the supply of power from the source to the sensor into discrete pulses of preselected duration.
47. In a process for operating a vehicle safety restraint system having an airbag, a battery power source which is independent of any other vehicle power source and a crash event sensor, the steps comprising:
(a) providing a microprocessor programmed to control system operation, wherein the microprocessor:
(i) applies power to the sensor for a time effecting stabilization thereof;
(ii) energizes the sensor with a discrete power input to determine the condition of the sensor;
(iii) powers down the system when no crash event is sensed and powers up the system when a crash event is sensed; and
(iv) cyclically repeats the energizing and powering down of the sensor for as long as no crash event is sensed.
48. A process as defined in claim 47 wherein the microprocessor continues energizing the crash event sensor when it identifies a crash event.
49. A process as defined in claim 48 wherein the airbag is deployed after the event is identified.
50. A restraint system for protecting vehicle passengers during a crash event comprising:
(a) a vehicle seat including a substructure frame attached to the vehicle;
(b) a safety belt having a first non-extensible part and a second extensible part, wherein one end of each belt part is attached to the vehicle seat sub-structure frame for extension from the points of attachment to the sub-structure frame across a passenger's lap;
(c) a substantially flat stiffening element extending substantially the entire length of the non-extensible belt part for establishing a substantially fixed orientation of the belt part with respect to the passenger's lap;
(d) an inflatable member mounted on the non-extensible part of the belt on that side facing away from the passenger's lap;
(e) a belt position orienting means operatively associated with the non-extensible belt part for maintaining the inflatable member mounted thereon facing away from the passenger's lap;
(f) a restraint system battery power supply which is independent of any other vehicle power source;
(g) an electrical switching combination contained in the belt part fastening structures that permit activation of the inflatable member only when the inflatable member is positioned facing away from the passenger's lap;
(h) a source of inflating gas operably joined to the inflatable member;
(i) a crash event sensor; and
(j) system electronics mounted on the seat substructure frame for electrically interconnecting the crash event sensor, the source of inflating gas, the battery power supply and the electrical switching combination.
51. An apparatus for controlling the operation of passive vehicle passenger restraint systems utilizing an inflatable cushion and a source of inflating gas, the apparatus comprising:
(a) a sensor responsible for transmission of a signal output reflecting the occurrence of a crash event;
(b) a restraint system battery power supply which is independent of any other vehicle power source;
(c) system electronics including (i) a microprocessor, (ii) and an oscillator and a firing circuit connected to the microprocessor, whereby discrete pulses of

pre-selected duration are supplied to the event sensor; and
(d) a housing enclosing at least the sensor, battery power supply and system electronics for shielding out radiant energy.